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Audit of Changes in Serum Urea and Electrolytes Following Peri-Operative Intravenous Fluid Therapy

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ABSTRACT

One thousand and eleven patients discharged from the postoperative recovery ward with intravenous infusions were reviewed in order to audit the extent of assessment of serum urea and electrolytes (U&Es) and the change in serum U&Es over the perioperative period. 69.7% had preoperative U&Es estimation, 42.5% had both a pre- and postoperative estimation and in 5%, only a postoperative estimate was undertaken. 12.2% of patients whose U&Es were measured had an abnormal preoperative serum potassium compared to 17.2% postoperatively (NS). Compared to a preoperative incidence of 13%, more patients (27.3 %) had an abnormal postoperative serum sodium ($p<0.0001$). There was a tendency towards postoperative hyponatraemia: 10.0% in the preoperative period compared to a postoperative 25.3% ($p<0.0001$). More tests were performed in the elderly (83.9% in age >65 years versus 69% in age 17-64 - $p<0.0001$) who were more likely to have electrolyte disturbances preoperative hypokalaemia ($p < 0.05$), postoperative hyperkalaemia ($p < 0.05$), postoperative hyponatraemia ($p < 0.03$) and raised serum urea, both pre- and postoperatively ($p < 0.0001$ and $p<0.0005$ respectively). Patients undergoing intra-abdominal procedures did not have significantly different peri-operative electrolyte abnormalities. Fewer tests were performed in emergency patients, who were hypokalaemic in the postoperative period compared to elective patients ($p < 0.01$). There was a higher incidence of preoperative hyponatraemia and raised serum urea in the emergency group ($p < 0.001$ and $p < 0.0002$ respectively). Neurosurgical emergencies often had a degree of preoperative hypokalaemia which persisted after surgery ($p < 0.0001$). Results indicate an increased risk of serum electrolyte abnormalities following peri-operative intravenous fluid therapy. However in the majority of patients, the magnitude of the change is not significant clinically.

Keywords: audit, anaesthesia, general, fluid therapy, electrolytes

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INTRODUCTION

Peri-operative fluid and electrolyte balance is a subject which has received considerable attention from clinicians and physiologists. However it remains a controversial and recurring topic of interest[1].

The management of intraoperative fluid therapy is the responsibility of the anaesthetist who will also prescribe the immediate postoperative intravenous regime. For the current practice in our institution, it is common to institute intravenous therapy for prolonged procedures, those in which blood loss may occur and those where there is potential for intraoperative fluid shifts. The composition of intravenous fluids varies from crystalloid solutions to those of artificial colloids and blood-derived products. What should be given and how much? This has been a constant source of debate in the literature[2]. In practice, it is the clinical impression that previously healthy patients with an uncomplicated peri-operative course tolerate even the most bizarre fluid regimens[3].

Little is known about the morbidity related to peri-operative fluid regimes[4-6]. Morbidity may be related to peri-operative electrolyte disturbances - hypokalaemia for instance, alters the electrical activity of the heart and predisposes to arrhythmias[7]. Recently, workers have reported alarming changes in serum electrolytes during intra-abdominal surgery and have reported the need for crystalloid requirements of 10-15 mL $kg^{-1}h^{-1}$ rather than 5-10 mL $kg^{-1}h^{-1}$[8]. These considerations prompted the following audit of peri-operative serum urea and electrolytes (U&Es) assessment. The main aims were to assess the extent of peri-operative electrolyte disturbances following intravenous therapy during current practice at our institution.

PATIENTS AND METHODS

All patients discharged to the general wards with an intravenous infusion after a general anaesthetic were identified by recovery ward staff. No effort was made to alter from the usual practice in the hospital concerning peri-operative assessment of urea and electrolytes (U&Es) or to standardise peri-operative intravenous therapy. The results of preoperative serum U&Es if performed, were recorded. The corresponding postoperative values were also recorded if performed within 48 hours after the operation. The patients were subdivided according to sex, age group, type of surgery and whether they were emergency or elective cases. The

distribution of serum U&Es estimation and the degree of peri-operative electrolyte changes could then be assessed.

Analysis: Data was logged onto a computer database (dBase IV*) for analysis using Epi Info** statistical package. Chi-square test was applied for comparison between groups. Relative risk (RR) and 95% confidence intervals (CI) were calculated and a p value less than 0.05 was considered significant.

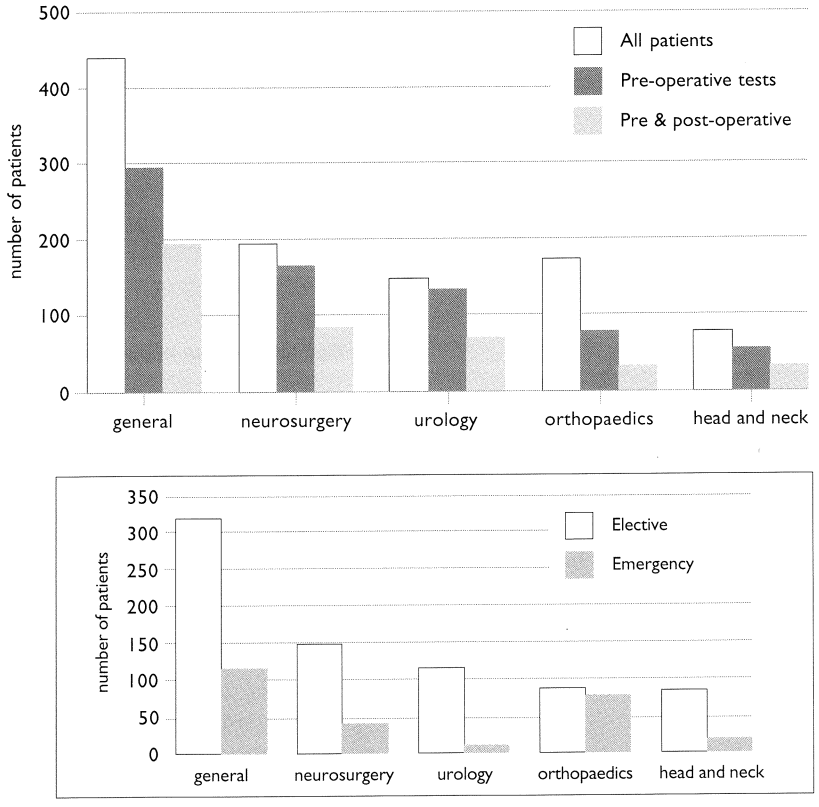
RESULTS

One thousand and eleven patients with intravenous infusions were discharged from the recovery ward over the 12-week period of the survey. The distribution of the patients according to surgical speciality is given in Fig 1. Seven hundred and sixty patients (75.2%) underwent elective surgery. The relative proportions of emergency to elective cases in each speciality is also shown in this figure. Five hundred and forty three (53.7%) patients were male and 468 (46.3%), female.

Distribution of serum U&Es

Four hundred and thirty (42.5%) patients had both pre- and postoperative U&Es checked while 705 (69.7%) had a preoperative check only. Fifty (5%) patients only had a postoperative check. The distribution of peri-operative U&Es estimations is shown in Fig 1.

Fig 1 - All patients - specialities (general, neurosurgery, urology, orthopaedics, head & neck). Specialities - elective/emergency



* dBase IV: a database program, Ashton-Tate corporation 1990.

** Dean AG, Dean JA, Burton AH, Dicker RC. Epi Info, Version 5: a word processing, database, and statistics program for epidemiology on microcomputers. USD, Incorporated, Stone Mountain Georgia, 1990.

The distribution of serum potassium in the peri-operative period is shown in Fig 2. Peri-operative hyperkalaemia is uncommon; hypokalaemia is more frequent [4.1% with preoperative hyperkalaemia versus 6.2% postoperatively (NS), 8.1% with low potassium compared to 11% postoperatively (NS)].

The distribution of peri-operative serum sodium is illustrated in Fig 2. More patients (27.3%) had abnormal postoperative serum sodium compared to a preoperative value of 13% (RR=2.1, 95% CI=1.65-2.65, p<0.0001). Peri-operative hypernatraemia is uncommon. Mild hyponatraemia ($125 < Na < 135$ mmol l^{-1}) is more common, especially postoperatively - 25.3% versus 10% preoperatively. Only 1 patient, a 75-year-old woman, presented for emergency abdominal surgery with a serum sodium less than 125 mmol l^{-1}(124 mmol l^{-1}). Overall, there was no difference in the incidence of abnormal serum urea over the peri-operative period.

Age

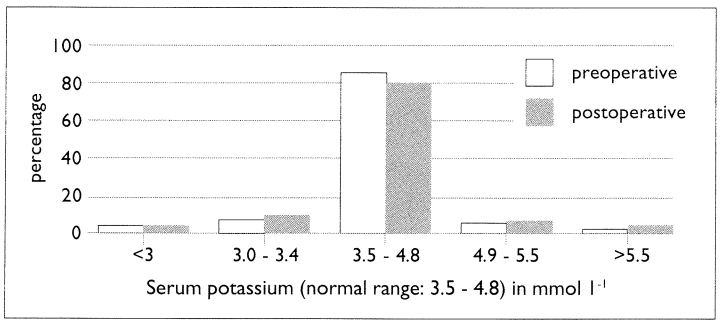
The elderly (age > 65) had more preoperative U&Es tests compared to the 'adult' (age 17-64) group (Table I).

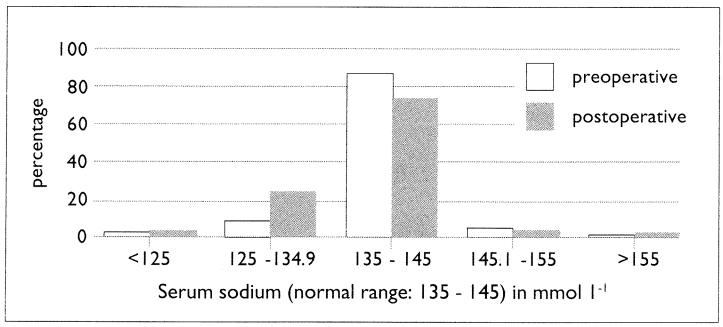
A significantly higher proportion of elderly patients had preoperative hypokalaemia (K<3.5 mmol l^{-1}) compared to the 'adult' group (RR=1.70, 95% CI=1.03-2.83, p<0.05). This trend was not apparent postoperatively but the incidence of postoperative hyperkalaemia was higher (RR=2.61, 95% CI=1.22-5.59, p<0.05). No difference was found in the incidence of preoperative hyperkalaemia. However, the elderly group with a preoperative serum potassium in the normal range were no more likely to develop postoperative serum potassium abnormalities compared to the 'adult' group. The incidence of preoperative hyponatraemia in the elderly is higher than in the 'adult' population, but did not reach statistical significance. Postoperative hyponatraemia is more prevalent in this age group (RR=1.57, 95% CI=1.06-2.57, p<0.03). The elderly were more likely to develop peri-operative hyponatraemia (RR=1.47, 95% CI=1.01-2. 17, p<0.05). A greater incidence of high preoperative serum urea (serum urea > 8 mmol l^{-1}) was found in the elderly compared to the 'adult' population (RR=2.51. 95% CI=1.80-3.50, p<0.0001). This trend was continued postoperatively (RR=2.00, 95% CI= 1.36-2.24, p < 0.0005).

Neurosurgery

In this group of patients, the incidence of pre- and postoperative hypokalaemia in the emergencies was found to be significantly higher compared to the elective group (RR=7.06, 95% CI=2.43-20.46, p<0.001 and RR=6.91, 95% CI=1.92-24.87, p<0.0002 respectively). No difference in preoperative hyperkalaemia could be detected. Overall, the percentage of neurosurgical patients developing postoperative hypokalaemia was not significantly different to the non-neurosurgical population. Emergency neurosurgical patients did

Fig 2 -Peri-operative serum potassium and sodium (percentage distribution)





not have a higher incidence of preoperative hyponatraemia and were no more likely to develop hyponatraemia compared to elective patients.

Intra-abdominal surgery

Out of the general surgical group, we selected patients who underwent intra-abdominal surgery. There were no differences in the incidence of peri-operative hypokalaemia or hyperkalaemia in this group compared to the other general surgical patients. Similarly, they were no more likely to develop peri-operative hyponatraemia and there were no differences in serum urea.

Elective versus emergency

Overall, 47.4% of emergency cases had preoperative U&Es tests compared to 77% amongst elective cases. Elective neurosurgical patients for instance, were more likely to have their U&Es checked compared to emergency cases (RR=2.83, 95% CI=1.77-4.52, p<0.001). However, there was no significant difference in the incidence of postoperative U&Es estimations in this group of patients.

There was no difference in the incidence of preoperative hypokalaemia between elective and emergency patients overall. However, more emergency patients were hypokalaemic in the postoperative period compared to elective patients (17.5% versus 8.8% respectively, RR=1.98, 95% CI=1.19-3.30, p<0.01). There were no differences in the incidence of hyperkalaemia, both preoperatively and postoperatively.

Emergency patients were no more likely than elective cases to develop hyponatraemia; however, more patients were hyponatraemic in the emergency group preoperatively (RR=2.22, 95% CI=1.40-3.53, p<0.001). The incidence of postoperative hyponatraemia was similar in the two groups.

There was a higher incidence of raised preoperative serum urea in emergency cases compared to elective ones (RR=1.76, 95% CI=1.26-2.45, p < 0.002). However, this tendency was not continued in the postoperative period.

Urology

In this group of patients, there was a higher incidence of raised serum urea compared to those undergoing non-urological surgery (RR=1.91, 95% CI=1.39-2.64, p<0.0003). No other significant differences were found.

DISCUSSION

Peri-operative serum U&Es estimations

The value of preoperative testing of serum U&Es has been questioned[9,10]. It has been suggested that this should only be carried out for those aged over 60 years[10], those on diuretic therapy and those with ASA (American Society of Anesthesiologists) grades 3 to 5[11]. In this sample, 69.7% had preoperative U&Es checked. This is compared to 47.1% in a previous survey[11] where they looked at a general sample of the surgical population, irrespective of whether they had intravenous therapy. This survey also confirms that more preoperative tests are carried out in the elderly (Table I). The results of this survey strongly support the recommendation that preoperative U&Es testing should be carried out in this age group; unfortunately, we cannot comment on ASA grades and the use of diuretics.

We were concerned that fewer emergency patients had preoperative U&Es estimation compared to elective patients, including such major subspecialities as neurosurgery. The value of checking postoperative U&Es has yet to be addressed. These findings suggest that the same considerations which apply in ordering a preoperative test should be all the more valid postoperatively, given that we have shown a demonstrable change in U&Es following intravenous therapy.

Table I - Age distribution of patients

Age group (yrs)	Number of patients	% with preoperative tests
< 16	100	22
17 - 64	550	69
> 65	361	83.9

Potassium

Potassium is probably the most important electrolyte under consideration[12]. Cellular excitability is related to the ratio of intracellular to extracellular concentrations[13]; alterations in this ratio will result in dysfunction of cell membranes and cause the symptoms of potassium imbalance. Acute hyperkalaemia is said to occur very rarely in the postoperative period; hypokalaemia is believed

to be more common[12] and this is substantiated by our findings.

The elderly have a higher incidence of preoperative hypokalaemia in this survey, which does not persist in the postoperative period; indeed there is a higher incidence of postoperative hyperkalaemia in these patients. Coupled with the findings of a generally raised peri-operative serum urea, it would be prudent not to administer intravenous fluids containing potassium to this population. This probably relates to the effect of the ageing process on renal function[14].

Emergency patients were more likely to exhibit postoperative hypokalaemia than elective patients, which may indicate inadequate peri-operative intravenous replacement therapy.

It has been calculated that potassium losses are about 100 mmol day^{-1} for the first 2 days after surgery[15], although these may be greater following bowel surgery. These losses should logically be replaced. It is not current practice in our institution to administer significant amounts of potassium in the immediate peri-operative period. The results of this survey indicate that in spite of those arguments, the incidence of postoperative hypokalaemia is low but not insignificant, especially in emergency patients. The critical level of hypokalaemia is unknown - 3.5 mmol l^{-1} has been generally accepted although some authors have found no major problems in patients with a serum potassium less than 3 mmol l^{-1}[16]. However, we have shown that a serum potassium level of less than 3.0 mmol l^{-1} is rare. Formal studies are required to determine whether significant amounts of potassium should be given in the immediate peri-operative period.

The contribution of potassium disturbances to postoperative morbidity is unknown. With the gradual introduction of computerised audit in anaesthetic practice, the prospect of correlating morbidity with peri-operative electrolyte shifts may become feasible.

Sodium

A serum sodium of 108 mmol l^{-1} and 115 mmol l^{-1} have been associated with postoperative convulsions, respiratory arrest and cerebral injury[17,18]. Hyponatraemia of this severity and hypernatraemia are very rare peri-operatively, although our survey confirms a definite tendency towards postoperative hyponatraemia (Fig 2). Again the elderly were more prone to peri-operative hyponatraemia, which further underscores their vulnerability and the need for postoperative checks in this age group.

Urea

A raised preoperative serum urea in the emergency group does not persist in the postoperative period. This, coupled with the persistence of postoperative hypokalaemia, probably indicates adequate peri-operative rehydration. The increase in serum urea in the elderly demonstrated in this survey is in accordance with previous work[19].

Intra-abdominal surgery

In this group of patients, surgical manipulation would have been expected to cause a degree of peri-operative ileus, thus altering fluid and electrolyte balance across the gut. We were unable to demonstrate any electrolyte differences in these patients despite the findings reported by Campbell et al[8] who reported the need to administer 10-15 mL $kg^{-1}h^{-1}$ intravenous as suggested by Shires[20], to fill up the 'third space'.

Neurosurgical emergencies

One possible explanation for peri-operative hypokalaemia in these patients would be the practice of rapid transit from the referring hospital via the CT scan and straight to the operating theatre without allowing time for correcting electrolyte abnormalities. Another explanation may belie in differences in the way head injured patients handle fluid and electrolytes homeostasis[21,22].

CONCLUSION

Our survey indicates an increased risk of serum electrolyte abnormalities following peri-operative intravenous fluid therapy. In this preliminary audit, we have identified subgroups of patients in whom these abnormalities would be of concern. However, in the majority of patients, it is reassuring that the magnitude of the electrolyte disturbances is unlikely to be of clinical significance.

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